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File Code: 3420 **Date:** September 17, 2007
Route To:

Subject: Bark beetle activity in the Warm Fire

To: District Ranger, North Kaibab RD, Kaibab NF

I visited the North Kaibab Ranger District at the request of Steve Boyer, District Silviculturist, on August 29, 2007. Steve requested that I survey the Wildland Fire Use portion of the 2006 Warm Fire for bark beetle activity. I describe in this report what bark beetle activity was observed within the fire boundary as well as other insect activity noted on the District. At the request of Steve I also provide information on tree deterioration rates following fire.

Bark beetle activity in the Warm Fire

Together with Steve Boyer and John Riling, Assistant Silviculturist, I made several stops along Forest Service Roads 225, 205 and 205B, and areas near Trail Canyon, to evaluate whether bark beetles where contributing to tree mortality within the Wildland Fire Use portion of the 2006 Warm Fire. At this point in time, the vast majority of new ponderosa pine mortality occurring during 2007 is due solely to fire effects. New mortality was primarily limited to trees with severe crown (>85% scorch and/or consumption) and bole (>75% cambium girdling) damage. Many of these trees also have a large number of woodborer (both Cerambycidae, Buprestidae) attacks that are characteristic of dead and dying trees (McHugh et al. 2003). At only one stop did we find bark beetle species typically associated with killing of ponderosa pine (Figures 1 and 2). Approximately 10 trees had been attacked earlier in summer along FS Road 205B by western pine beetle. One additional tree was located at this site that was currently infested with western pine beetle. A limited number of severely damaged ponderosa pine had been attacked by red turpentine beetle. These beetles are generally not considered to be tree killers, although they may contribute to the death of already heavily fire-damaged trees (Smith 1971).

Figure 1. *Ponderosa pine mortality occurring in 2007 was limited to trees with >85% total crown damage such as the middle tree shown in picture on the left. A small pocket of ponderosa pine mortality caused by western pine beetle was observed along FS Road 205B. Picture on right shows attacked tree with pitch tubes.*

Although western pine beetle, red turpentine beetle and pine engraver species may be attracted to fire-damaged pine trees (Miller and Patterson 1927, Miller and Keen 1960, Smith 1971, DeMars and Roettgering 1982, Bradley and Tueller 2001, Ganz et al. 2003, McHugh et al. 2003), other species, such as mountain pine beetle, do not seem to be attracted fire-damaged pine trees (Ryan and Amman 1996, Rasmussen et al. 1996, McHugh et al. 2003). Recent studies have demonstrated the importance of bark beetles in models of post-fire mortality of ponderosa pine trees (McHugh et al. 2003, Wallin et al. 2003, Sieg et al. 2006). In general, bark beetles attacks occurred on trees sustaining greater crown damage, with increased probability of bark beetle attack at total crown damage levels above 50% (McHugh et al. 2003). However, trees must have enough green phloem for successful bark beetle attack and brood production (Parker et al. 2006); thus, trees sustaining severe bole damage may not be a viable host.

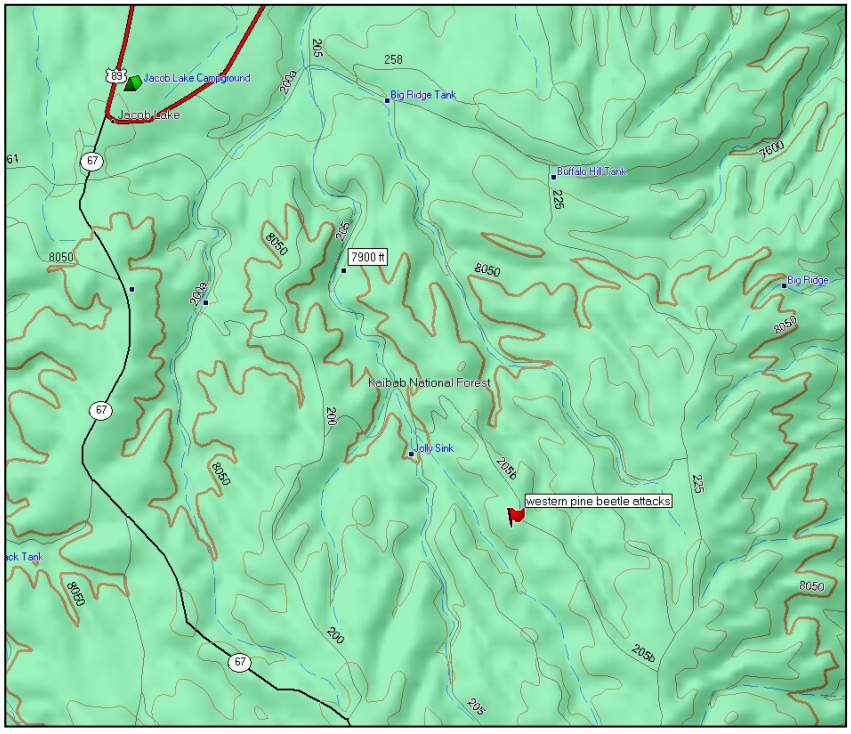

Figure 2. *Location of western pine beetle attacked trees within the Warm Fire Wildland Fire Use area.*

Based on recent aerial detection surveys conducted by our office and the limited observable bark beetle activity during this survey, populations of bark beetles are at endemic levels across the District at this time. While bark beetle attacks often increase tree mortality at a given level of fire damage to the crown (McHugh et al. 2003, Sieg et al. 2006), the magnitude of the increase seems to vary between endemic and outbreak populations of the primary tree-killing beetle species (Breece et al., in press).

In addition to evaluating ponderosa pine for bark beetle activity, we also examined other tree species for bark beetle activity. A limited amount of fir engraver activity on fire-damaged white fir was observed in drainages along the northeast portion of the fire (i.e., east side of FS Road 225 and near Trail Canyon). Aerial detection surveys by our office over the last several years have detected elevated fir engraver-caused white fir mortality across the District indicating populations of this beetle have been high for some time. Thus, although not much research has been conducted on the interaction between fire-damaged hosts and this beetle species (Hood et al., internet presentation), it does not seem there like there is much potential threat of an outbreak starting as a result of the fire.

Tree deterioration and fall rate of fire-damaged trees

Deterioration of dead trees is caused by fungi, insects (both directly and indirectly by vectoring in decay fungi), and weathering (reviewed in DeNitto et al. 2000). The three most common deteriorations are blue stain, decay and weather checking. Blue stain is discoloration in sapwood of dead trees caused by non-decaying fungi, and does not affect the structural integrity of wood. Decays are caused by fungi that break down wood cells by enzymatic action, thus causing significant loss of wood strength (Panshin and de Zeeuw 1980). Decays can affect sapwood and heartwood of trees. When trees begin to dry out after death they lose moisture, shrink and develop cracks. Weather checking is often most common in upper boles of trees, and on hot, dry, or windy sites. These cracks can be entry points for decay fungi, but once trees slough off their bark, they often become too dry for fungi to be successful. Cracks also reduce the strength of affected wood.

Several factors influence the rate of deterioration of fire-killed trees, including: tree species (white fir deteriorates faster than pine and Douglas-fir), species characteristics (such as bark thickness and the ratio of sapwood to heartwood), tree size, local site conditions, severity of the fire, and time of year the burn occurred (reviewed by Lowell et al. 1992). Different combinations of these factors result in varied rates of deterioration. However, in general, blue stain will appear in susceptible trees within the first year, some sapwood will be decayed in the second year, and sapwood of most conifers will be unusable after three years, especially in smaller trees and the tops of larger trees (Kimmey 1955). Decay of the heartwood can take much longer (>5 - 10 years), especially of large diameter trees.

Based on a study of fire-killed ponderosa pine from two fires in near Flagstaff, most trees were standing 3 years post-fire, but after 7 years, 41 % had fallen (Chambers and Mast 2005). Similarly, a study on fall rate of mountain pine beetle-killed ponderosa pine trees in Colorado found the average fall rate was about 3 – 5% per year beginning in year 3, unless winds exceeded 75 mph. Trees generally broke off within 2 feet of ground level (Schmid et al. 1985).

Bark beetle activity in De Motte Campground

We also visited the De Motte Campground to evaluate the developed recreation site for bark beetle activity. Approximately one year previously, Steve and I also visited De Motte and found three 12-14 diameter trees that had been attacked by roundheaded pine beetle (*Dendroctonus adjunctus*) within the recently renovated and redesigned campground. In addition, two larger diameter pines had apparently successfully pitched out attacking beetles. I recommended at that time the District cut and remove the three infested pines as soon as possible. Although it is unclear as to the actual timing, the trees were likely felled in the fall after beetles had already emerged as infested trees identified this year were adjacent to the previously attacked trees.

Roundheaded pine beetle typically flies short distances as long as suitable host trees are available nearby. Roundheaded pine beetle is unique among tree-killing bark beetles in Arizona as its primary flight occurs during the fall (end of September through November) (Massey et al. 1977). Therefore, it is recommended that the infested trees be removed prior to October before adult beetles emerge and fly to attack additional nearby trees. Felling of infested trees will not kill developing brood or adults; infested trees must either be removed from the site or treated on site.

Trees growing in developed recreation sites are often chronically stressed due to repeated damage caused by campers and soil compaction caused by roads and large vehicles parked off-road. In addition, the recent renovation and vegetation treatments within De Motte likely contributed to the short-term stress of residual trees. However, because populations of bark beetles attacking ponderosa pine are at relatively low levels, it does not seem that preventative spraying is justified at this time. Monitoring of bark beetle activity through surveys of the campground should be conducted a regular basis. If newly attacked trees are identified, they should be removed as soon as feasible.

Spruce budworm activity

Based on recent observations by Russ Truman that western spruce budworm activity is occurring northwest of De Motte Campground near Forest Service Roads 765 and 766, we conducted a brief drive through of this area. Low to moderate levels of western spruce budworm defoliation of white fir, Douglas-fir and spruce were observed throughout the area (***Figure 3***). Although damage was readily observable from the ground, it was not seen during our recent aerial detection survey of the District. This further suggests that damage levels are still relatively low. However, an increase in budworm defoliation has been recorded throughout other areas of the Southwestern Region in 2007, including the Chuska Mountains on the Navajo IR to the east of the District.

Figure 3. *Western spruce budworm caused damage to white fir adjacent to Forest Service Road 765.*

The western spruce budworm defoliates the new growth of its hosts (Fellin and Dewey 1982). In the Southwest, these are principally white fir, Douglas-fir, blue and Engelmann spruce, and corkbark fir (Linnane 1986). Outbreaks can result in tree growth loss, top-kill, destruction of seeds and cones, and tree mortality. These impacts are directly related to the intensity and duration of outbreaks. Forest stands most susceptible to western spruce budworm are dense, multi-storied with white fir and Douglas-fir predominating in the overstory and shade tolerant species in the understory (Linnane 1986). We observed the budworm defoliation to be occurring in this type of stand conditions.

If you have any questions regarding my assessments and recommendations, please do not hesitate to contact me.

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